

Energy Efficiency & Environmental News: Energy in Garbage¹

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ENERGY IN GARBAGE

Introduction

People make garbage. In 1990, the near 13 million people in Florida produced 19.4 million tons of garbage. Two point eight tons of this waste (15%) were recycled, 3.1 million tons (16%) were burned in Florida's waste-to-energy plants (Table 1), and 13.4 million tons (69%) went to the 150 permitted landfills in Florida.¹

Recycling: Energy Conservation

Recycling saves energy (Table 2). The raw materials for the production of plastics are 70% natural gas and 30% oil.² The 66 million BTU savings per ton of finished plastic bottles is enough energy to fill a 20-gallon gasoline tank every week for 10 years.

Studies report that 47%-74% of the energy used to produce steel from feedstock is saved by using scrap.³ Based on an energy demand of 21,800,000 BTU per ton of steel produced, a 50% savings equals the energy required to keep 12 40-watt fluorescent light bulbs shining for an entire school year per ton of recycled steel scrap.

At current Florida recycling rates, 22.4 trillion BTUs of energy are saved (Table 3). By 1994, 50 percent of all newsprint, aluminum, plastic bottles and glass used in the state must be recycled.⁴ This will save 43.1 trillion

BTUs of energy, almost 8% of all of the energy consumed by industry in Florida in 1988.

Studies show that cities with curbside collection can achieve a 70-90% capture rate of recyclables; cities with buy-back centers capture 20%; drop-off systems capture 10%.⁵ It is clear that recycling will be making an ongoing and significant contribution to energy conservation and resource conservation and function in a fundamental way in support of our necessary journey towards becoming a sustainable society.⁶

Waste-to-Energy (WTE)

On average, each pound of unprocessed garbage burned at a WTE plant generates 250 watt-hours of electricity, enough to keep a 60-watt bulb shining for over four hours. Refuse derived fuels (RDF) have heating values up to 8,000 BTU per pound (400 watt-hours). Minimally processed RDF is garbage which has been shredded and sent through a magnetic separator to remove iron-based objects.⁷ In Florida, Miami-Dade County, Lakeland and West Palm Beach burn RDF.

In 1990, the 11 WTE plants in Florida burned about 8,500 tons of garbage per day, using 72% of their combined total capacity.⁸ In 1988, the state's WTE facilities produced 1.7 GWh of electricity, 0.001% of the electric energy generated in the state.

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1. This document is the January 1992 issue of Energy Efficiency and Environmental News, the newsletter of the Florida Energy Extension Service, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Publication date: January 1992.
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The Florida Energy Extension Service receives funding from the Florida Energy Office, Department of Community Affairs and is operated by the University of Florida's Institute of Food and Agricultural Sciences through the Cooperative Extension Service. The information contained herein is the product of the Florida Energy Extension Service and does not necessarily reflect the views of the Florida Energy Office.

Location	Design Capacity (tons/day)	Produces	MW Capacity	Pollution Controls
Panama City	510	elec ²	12.0	elec stat precip ³
Miami-Dade County	3000	elec	78.5	elec stat precip
Miami-Int'l Airport	60	steam	-	ab
Brandon	1200	elec	29.0	elec stat precip
Key West	150	elec	4.0	elec stat precip
Okahumpa	528	elec	12.5	dry acid gas scrubber fabric filter
Lakeland	300	elec	7.8	elec stat precip wet acid gas scrubber
Mayport	50	steam	-	cyclone separator
Tampa	1000	elec	22.0	elec stat precip
West Palm Beach	2000	elec	61.3	elec stat precip dry acid gas scrubber
St. Petersburg	3000	elec	75.0	elec stat precip
Pompano Beach	2250	elec	66.5	fabric filter dry acid gas scrubber
Ft. Lauderdale	2250	elec	64.0	fabric filter dry acid gas scrubber
Hudson	1050	elec	31.2	fabric filter dry acid gas scrubber
Total	11798		463.8	

¹ Department of Environmental Regulations (DER), State of Florida, Solid Waste Management in Florida, 1990 Annual Report.

² electricity

³ electrostatic precipitator

Particulate matter, sulfur dioxide, nitrogen oxide, hydrogen chloride, hydrogen fluoride, metals, carbon monoxide, hydrocarbons and chlorinated organics (dioxins and furans) are the commonly characterized emissions from WTE facilities.⁹ Waste presorting can substantially reduce flue gas and bottom ash heavy metals and reduce emissions of carbon monoxide, hydrogen chloride, hydrogen fluoride and nitrogen oxide.¹⁰ A substantial opportunity exists to improve stack emissions by removing suspected sources of mercury, lead and chlorine pollutants such as batteries and vinyl plastics from the garbage before it is burned.

The Environmental Protection Agency (EPA) is developing air emission standards for WTE plants (Table 4). There are several types of pollutant control devices used in WTE plants (Table 5), and their abilities to remove pollutants from the WTE exhaust air stream depend upon how the WTE plant

Table 2. Energy Savings When Materials Are Reused.

Material	Million BTUs
Glass	4.4 per ton of recycled glass ¹
Plastic bottles	65.8 per ton of finished bottle ²
Newsprint	13.1 per ton of recycled fibers ³
Corrugated paper	5.0 per ton of products produced ⁴
Aluminum	219.0 per ton of products produced ⁵
Steel	10.9 per ton of recycled scrap ⁶

¹ Schuller, P.D. 1990. "Recycling Policy Options for Energy Conservation," presented at "Energy Aspects of Solid Waste Management," proceeding of the 18th Annual Illinois Energy Conference, Chicago, Illinois.

² Sellers, V. and Sellers, J.D. 1989. "Comparative Energy and Environmental Impacts for the Delivery of Soft Drinks in Nine Containers,": Franklin Associates, National Association for Plastic Container Recovery.

³ Tillman, D. 1983. "Evaluating the Potential Contribution of the Forest Products Industry to U.S. Energy Supplies," proceedings of the Ninth Cellulose Conference.

⁴ Love, P. 1978. "Energy Savings from Solid Waste Options," Resources Policy.

⁵ Powel, J. 1981. "Energy Savings from Recycling Waste material," Bio Cycle. March-April 1981.

⁶ Schuller, P.D. 1990. "Recycling Policy Options for Energy Conservation," presented at Energy Aspects of Solid Waste management," proceedings of the 18th Annual Illinois Energy Conference, Chicago, Illinois.

is managed and the devices which are installed in sequence (Table 6). The combination of a scrubber and fabric filter can remove 97 to 99% of the dioxins present in postcombustion flue gases.¹¹

Energy from Landfills

Every year a typical pound of landfill garbage makes approximately 0.10 cubic feet of gas. Approximately 50% of this landfill gas is methane, a burnable energy source.¹² The 26.8 billion pounds of garbage buried in Florida in 1990 generated 1.3 billion cubic feet of methane in 1991. Garbage produces gas for 20-30 years, decreasing over time. Between 2 and 20% of the world's methane emissions are estimated to come from landfills.¹³

Gas production in a landfill is hard to control. Gas production is enhanced when uniform garbage decomposition occurs and when adequate water is available. New landfills have been designed to keep water out of the landfill to prevent leachate runoff. The removal of yard waste and paper products from the

waste stream, by composting/recycling programs reduces the landfills capacity to produce methane.

Therefore, Bogner¹⁴ described two types of landfills: the geofill and the biofill. Geofills are landfills full of garbage that doesn't decompose well (e.g. WTE ash disposal sites). Since the garbage doesn't break down well, not a lot of methane is produced, hence the name geofill--the placement of waste in geologic storage.

A biofill is a landfill designed and operated for maximum methane generation and recovery. The Northeast Landfill Power Project in Johnston, Rhode Island, is such a landfill. This landfill accepts 4,000 tons of garbage per day plus the sludge from 22 municipal wastewater treatment plants. There are currently 100 active wells sunk into the landfill. An induced vacuum draws the landfill gas into the 3.5 miles of slotted pipe snaked throughout the landfill towards the well heads. The landfill gas-to-electricity

Table 3. Florida Municipal Solid Waste¹.

Waste Type	Generated (tons/1989-90)	Recycled (tons/1989-90)	Energy Conserved as Materials Reused (trillion BTUs)	Energy Conserved at 50% recycle rate (trillion BTUs)
Newsprint	1,479,000	376,000	4.93	9.69
Corrugated paper	1,935,000	282,000	1.41	- ²
Aluminum	168,000	69,000	15.1	18.4
Plastic bottles	405,000	9,000	0.59	13.3
Glass	757,000	88,000	0.39	1.67
Total	4,744,000	824,000	22.4	43.1

¹ DER, State of Florida, Solid Waste Management in Florida, 1990 Annual Report.

² Not included in mandate.

power project generates 13.6 MWs; 1.3 MWs are used to run the system, 12.3 MWs are sold to an electric power plant.¹⁵

The highest U.S. tipping fee is \$120-160/ton in New York City.¹⁶ Monroe County, Florida weighs in at \$110/ton. The harvest and sale of landfilling methane gas from biofills as an energy resource can generate money to cover part of the cost of landfilling.

Energy from Garbage: The Future

Anaerobic digestion--the decomposition of organic materials by tiny organisms which survive only in places where there is no oxygen--is the focus of current university research. Organic materials--food wastes, yard wastes, paper--make up 53% of the garbage generated in Florida.¹⁷ Scientists estimate that one pound of anaerobically digested organic matter can produce 10-14 cubic feet of gas. Approximately half of this gas is methane, the rest is basically carbon dioxide.¹⁸ The material remaining after digestion is compost and can be used as a soil amendment.

In a study funded by the Florida Energy Office in 1989, Drs. Chynoweth and Earle, Agr. Eng. Dept., Univ. of Fla., tested a sequenced batch anaerobic composting (SEBAC) process using municipal solid waste. Experimentation produced, on average, 3,193 BTUs of energy per pound of organic matter and

reduced the volume of the material introduced to the process by almost 50%.¹⁹

Conclusion

Recycling saves energy; waste-to-energy plants make energy from garbage; landfills can be mined for the methane they produce. The inputs and outputs of each of our solid waste management options must be carefully evaluated by us, the public, so that our garbage is managed efficiently and economically with environmentally-sound technology.

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Table 4. EPA Standards for Existing WTE Facilities, > 1,100 Tons Per Day^a.

Pollutant	WTE Type	Limit ^b	Conditions
Carbon monoxide, CO	MB ^c waterway/refractory	100 ppmv ^d	4 hrs
	MB rotary wterwall	250 ppmv	24 hrs
	RDF stokers	200 ppmv	24 hrs
Dioxins/furans, PCDD/PCDF		60 ng/dscm ^e	
Particulate matter, PM		34 mg/dscm	
Sulfer dioxide, SO ₂		70% removed or 30 ppmv	24 hrs avg
Hydrogen chloride, HCl		90% removed or 25 ppmv	

^a Getz, N.P., C.K. Amos, Jr., P.C. Siebert. 1991. "Air Pollution Control Systems and Technologies for Waste-to-Energy Facilities." *Energy Engineering*, Vol. 88, No.6.

^b All at 7% O₂, dry basis.

^c Mass burn.

^d Parts per million, by volume.

^e Nanogram/dry standard cubic meter.

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Table 5. Pollutant Control Devices¹.

Type	Removes	Principal	Comments
Electrostatic Precipitator (ESP)	PM; some PCDD/PCDF	magnetic attraction	performance depends on sizing, flue-gas flow, particles ability to accept charge, particle size; flue gas temperatures
Fabric Filter (FF)	PM	vacuum cleaner, strainer	greater acid gas removal efficiency than ESP
Wet acid gas scrubber (WSCR)	acid gas; PM; some PCDD/PCDF	chemical bonding	continuous stack steam plume; liquid discharge
Dry Sorbent Injection (DSI)	acid gas; PM some PCDD/PCDF	chemical bonding	dry sorbent injected into flue gas by high pressure air
Spray Dryer Absorber (SPA)	acid gas; PM some PCDD/PCDF	chemical bonding	required by EPA guidelines for existing WTE facilities > 1,100 TPD; no continuous stack plume; no wastewater

¹ Getz, N.P., C.K. Amos, Jr., P.C. Siebert. 1991. "Air Pollution Control Systems and Technologies for Waste-to-Energy Facilities." *Energy Engineering*, Vol. 88, No. 6.

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SIMPLY SAVING

Energy Efficient

Economical

Environmentally Sound

People make garbage. In 1990, the 13 million people in Florida produced 19.4 million tons of garbage. There are three things we can do with waste once it has been generated: recycle it, burn it, or place it in a landfill (Figure 1).

Recycling saves energy. The 66 million BTU saving per ton of finished plastic bottles is enough energy to fill a 20-gallon gas tank every week for 10 years. At current Florida recycling rates, 22 trillion BTUs of energy are saved. At mandated 1994 recycling rates over 43 trillion BTUs of energy will be conserved as the paper, plastic, aluminum, and glass fibers are returned and reused; 43 trillion BTUs could power all of Florida's industries for a month.

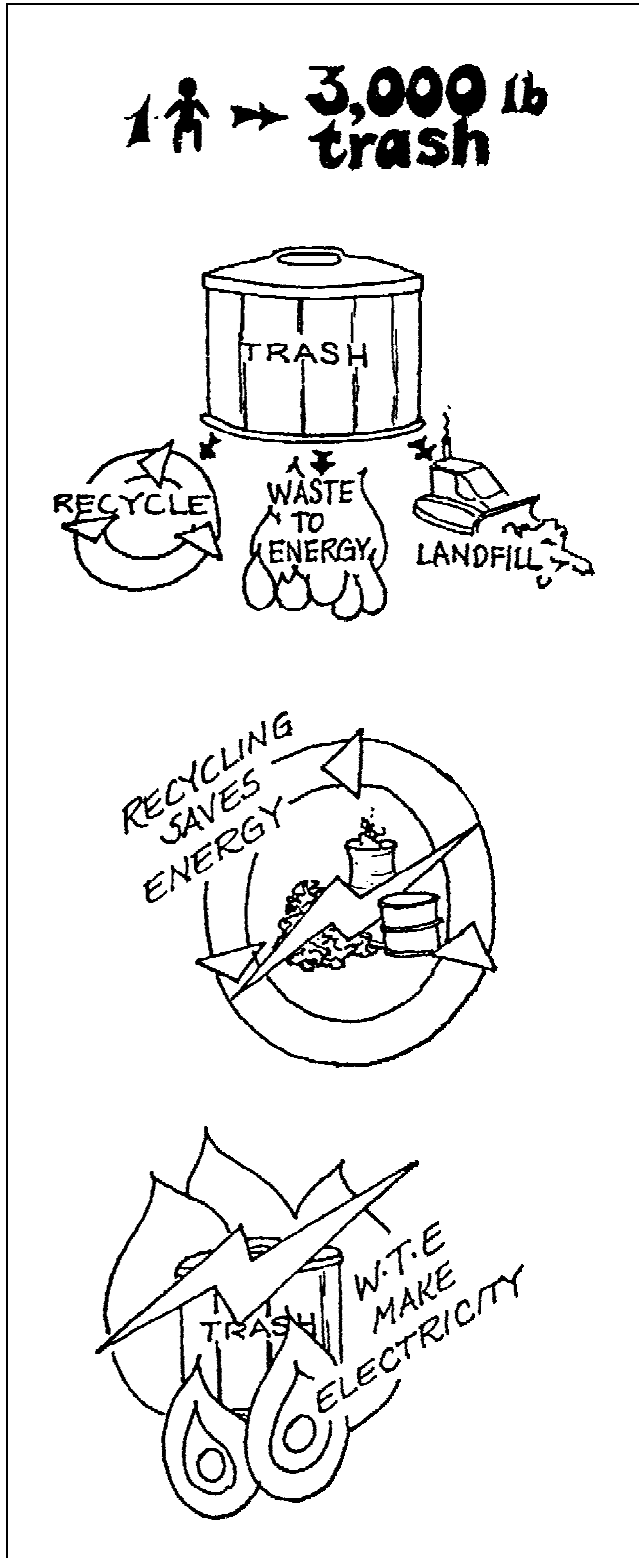


Figure 1. Use Waste To Produce Electricity.

One pound of garbage can produce 0.25 KWh of electricity at a waste-to-energy (WTE) plant; 250 watt-hours can keep a 60-watt light bulb shining for over four

hours. In 1988, Florida's WTE plants produced 1.7 GWh of electricity, 0.001% of the electricity generated in the state. There is concern over the pollution potential of some WTE facilities. Recycling programs, to remove sources of pollutants before they reach the WTE plant, and "scrubbing" technologies, effectively employed at the WTE facility, can help contain pollutant levels within the limits being set by the Environmental Protection Agency.

Twenty pounds of garbage in a landfill can produce one cubic foot of methane in a year. Methane is the energy resource in natural gas. The 26.8 billion pounds of garbage buried in Florida in 1990 generated 1.3 trillion BTUs worth of unused methane in 1991. Research is developing controlled systems to efficiently produce and capture this methane from the organic portion of garbage.

Recycling saves energy; waste-to-energy plants make energy from garbage; landfills can be mined for the methane they produce. The inputs and outputs of each of our solid waste management options must be carefully evaluated by us, the public, so that our garbage is managed efficiently and economically with environmentally-sound technology.

Simply Saving is written to be used by Cooperative Extension Service field faculty within their extension education programs as a newspaper or newsletter column. The body of E² & E provides more in depth information on the subject. Please forward comments regarding writing style and topic to Helen Helikson Whiffen GNV::HJH.

Table 6. Pollutant Control Systems Comparison¹.

System	PCDD/PCDF	HCl %	SO ₂ %	Energy	Maintenance \$
SDA/ESP	<	90	70	<	<
SDA/FF	>	95	85	>	>
DSI/ESP	-	50	50	-	-
DSI/FF	-	90	50	-	-
SDA	≥	≥90	≥70	>	>
DSI	≤	≥50	50	<	<
WSCR	-	99	90	-	high

¹ Getz, N.P., C.K. Amos, Jr., P.C. Siebert. 1991. "Air Pollution control Systems and Technologies for Waste-to-Energy Facilities," Energy Engineering, Vol. 88, No. 6.

